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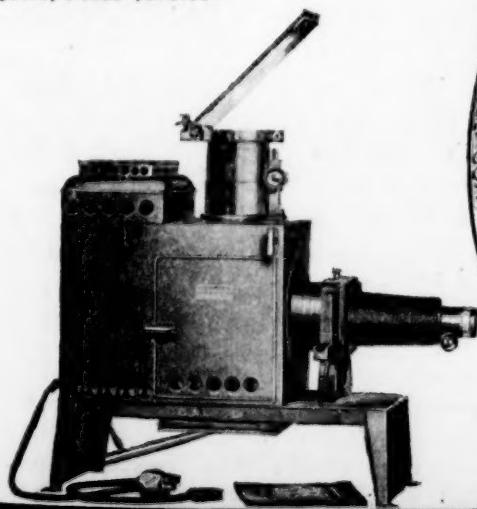
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# SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to The Editor of *Science*, Garrison-on-Hudson, N. Y.

## AGRICULTURAL BOTANY IN SECONDARY EDUCATION<sup>1</sup>

THE advance of physical science during the past century, and the application of the results gained therein to industry, and especially to the means of transportation and intercommunication, have made desirable and available, areas of the earth's surface hitherto unsought or inaccessible. Because of the development of mechanical agencies through science, the present age, more than any other, is characterized as an age of economic exploitation. The freedom and mystery of the older earth are departing, and soon will be gone forever. Never again will there be another *Odyssey*. The spirit of the new Age of Steel is over us—the spirit of exploitative and capitalized industry, that is reaching with magnificent ease out to the remotest confines of the planet, uncovering all the secret places, and blazing plain bare trails athwart the earth, straight to the very capitals of the ancient fairylands of geography. What mystery is there left in Peking or Timbuktu, in Samarkand or Candahar? To commerce, the names of the nations are but words in a game; their habitations but the squares of red and black on the chess board upon which the game is played; their remoteness a mere relativity of cost of communication.

In a sense that is far from Emerson's this spirit is embodied in the words:

Far or forgot to me is near,  
Shadow and sunlight are the same,  
The hidden gods to me appear,  
And one to me are shame and fame.

The first exploitation of new territories has always been made by adventurers driven by the primitive Wanderlust; by men impatient of sitting in sodden security, but ever eager

<sup>1</sup> Address before the Iota Chapter, Sigma Xi, University of Kansas.

to voyage on and try the hazard of new fortunes. It is to men like these that we owe the opening of new regions to settlement. In them through all ages has spoken the soul of Odysseus:

Push off, and sitting well in order, smite  
The sounding furrows, for my purpose holds  
So sail beyond the sunset and the baths  
Of all the western stars, until I die.

The world, however, has passed through this epoch. No new lands lie under the sun waiting discovery, for the earth's surface, in all its essentials is roughly known. The home of El Dorado, the Fountain of Perpetual Youth, the Seven Cities of Cibola, Bagdad, the Land of Ophir, Cipangu, Lhassa, the country of Prester John and the city of the Great Khan, like the Poles of the Earth and the "Old Moon Mountains African,"—all these have faded out of the romanticism of twilight obscurity into the daylight monotony of the commonplace. Magical names that once lured mankind, have vanished like the Wagnerian gods, over some rainbow bridge into the Valhalla of their own romance.

We will do well to pause for a moment to contrast the modern movement that is enmeshing the earth in a net of industrial enterprises, with the spirit of the Age of Discovery just closing, that we may better orient educational work with respect to future necessities and present demands. Especially is this required of the sciences, upon the development of which industry depends. In the field of biology, the extent to which botany becomes an effective factor in modern education, depends very largely at the present time, whether we will it so or not, upon the degree to which it can be brought to efficiently cooperate in practical affairs.

For our greater and our lesser happiness, the boyhood of the human race is past. We are growing up socially and economically, and the inevitable outcome is going to be the mastery of the globe by means and for ends that are scientifically economic, and in the long run unquestionably altruistic. If this development means the elimination of mystery and glamor so far as the earth's surface is

concerned, it yet remains for biologists to exploit the deeper mystery and the more thrilling story of life itself in all its protean forms upon that surface. If this transformation means the elimination of the poetry of the naïve childhood of the race, we may yet, perchance, find a higher poetry in the grander rhythm of a developing social life and a more harmonious evolution of wider racial ideals. Such at least are the deeper reflections of science—science that has come both to destroy and to fulfill.

In no other field of industry is the scientific age working greater changes than in agriculture. The oldest, the most primitive and the most necessary of occupations, agriculture, has been, until the last century, the field most neglected by science. In the older countries of Europe, a sharp social stratification, involving contempt for manual labor among the so-called upper classes, has been one of the retarding factors in agricultural development. Agriculture there is still largely the occupation of the peasant, and for the most part, the university and the peasant never meet. While this is rather a bald and radical statement of the situation, it holds good in its general outlines for most of the European states operating under the aristocratic systems of the past, while in the rest, the prejudice referred to still survives as a social memory.

In our own country, settled at the outset by immigrants who chiefly came from a body of land-loving and free-holding people, social prejudice toward agriculture is a comparatively minor matter, economically speaking. Strange to say, however, the very favoring conditions of our environment have hindered agricultural development along scientific lines. Our land was originally boundless and seemingly inexhaustible. It was impossible not to make a living on a farm, and anybody could become the possessor of one. There were no agricultural economic problems to solve, beyond the question of markets for the surplusage of the farm. What wonder that agriculture awakened scant interest in the scientific world. If the soil began to yield less as the years went by, under a wasteful,

extravagant one-crop system, there was always more cheap land farther west, to which emigration could proceed. Furthermore, although social prejudice was largely eliminated in America, the utter ease and simplicity with which a living could be gotten out of the land on the one hand, and the relatively small cash returns and the severe discomforts of farm life on the other, have correspondingly continually operated to tempt the more ambitious minds away from the farm. Something that anybody can do, does not appeal to the more enterprising and gifted individuals. Not only that, but the youth who ventured his fortunes in business or the professions, embarked the more confidently perhaps, because of the feeling that if he failed elsewhere, he could still always go back to the farm as a last resort and make his living. Conditions, however, have radically changed. Not only is agriculture no longer the simple occupation it once was, but the greater portion of the best land is now under the plow. No new soil resources remain to be drawn upon, except in the dry plains area, and the arid regions of the west, upon the development of which nature has imposed severe limitations which can never be entirely removed. The torrent to the west has dwindled to a trickling stream, and from now on we must bend our energies toward the building up of the lands that have already been exploited in a pioneer way.

The population of the country is now under present methods overtaxing the cultivated land for its support. It has been said that we are consuming thirteen months of wheat every twelve months. The ratio of those engaged in agricultural pursuits, to those engaged in all other occupations, in the decades since 1870 is as follows:

TABLE I

Year	Ratio of Those Engaged in Agriculture to Those in Other Occupations	Year				
		1910	1900	1890	1880	1870
1870	1: 2.10					
1880	1: 2.24					
1890	1: 2.65					
1900	1: 2.80					
1910	1: 3.01					

In other words, whereas in 1870 one person engaged in agriculture represented two persons engaged in other occupations, in 1910 there were three persons in other occupations to one in agriculture.

In respect to percentage of the population, the following relationship is found to exist.

TABLE II

Year	Per Cent. of Total Population Engaged in Agriculture
1870	15.43
1880	15.38
1890	13.68
1900	13.66
1910	13.76

In the forty-year period up to 1910, the percentage of the total population engaged in agricultural pursuits fell off 1.67 per cent. while the percentage relation of the ratio of the number engaged in agriculture to those in the other classified occupations, meaning thereby largely, effective young and adult males, has widened by 30 per cent. since 1870.

If we now turn to the rate of production in agriculture for the same period, dividing the United States into more or less homogeneous districts, we find the acre-value of all agricultural products raised in the different crop-growing regions of the country to be as follows:

TABLE III

Region	Year					
	1910	1900	1890	1880	1870	Average
North						
Atlantic . . .	\$19.03	\$11.70	\$9.90	\$7.85	\$12.83	\$12.26
Middle						
Atlantic . . .	14.06	9.75	9.21	9.99	16.00	11.80
S. Atlantic and Gulf . . .	16.17	8.85	8.44	7.82	12.27	10.71
Central . . .	11.62	7.09	6.69	7.63	12.46	9.10
North Central	11.35	7.15	7.34	8.64	16.02	10.10
Plains . . .	8.48	5.56	4.50	5.15	15.27	7.79
Rocky Mountain . . .					18.24	9.10
Pacific . . .	12.75	7.50	6.82	5.78	7.85	8.14
Average . . .	\$12.50	\$ 7.97	\$7.44	\$7.63	\$13.87	\$ 9.88

From the above table, there appears to be no consistent, consecutive increase in the

acre-value of farm products for any of the regional divisions in the United States during the period in question—something more than a generation. The vertical columns show a remarkable harmony of acre-values over the whole United States for the same census year. This fact, coupled with an entire absence of any uniform upward trend of values for the period, either for the regions individually, or for the United States as a whole, clearly demonstrates that the acre-values of American farm products for the past generation have been entirely dependent upon accidental years of good crops or good prices or both.

The situation is still more strikingly set forth when we compare the percentage increase or decrease in improved acreage from one decennial census period to another, with the percentage increase or decrease in the acre-values of agricultural products for the same period, as shown by the following table.

average net increase for the four decennial periods, as shown in the last two columns. Here however, the fact is demonstrated, that in practically every agricultural region in the United States, the average net percentage increase in the improved acreage for the forty-year period, has out-distanced and in most cases greatly outstripped the corresponding percentage increase in acre-value of production upon that acreage. Surveying the figures in more detail, we find that in the most typical agricultural regions of the country—in the South Atlantic and Gulf and in the Central region—the manner in which the percentage increase in acre-value of farm products falls behind the percentage increase in the improved land under cultivation, gives just cause for consideration. When we consider that in the Central region, the states of Arkansas, Illinois, Indiana, Iowa, Kentucky, Missouri, Ohio, Tennessee, and West Vir-

TABLE IV

Region	1870-1880 Per Cent. In- crease or De- crease		1880-1890 Per Cent. In- crease or De- crease		1890-1900 Per Cent. In- crease or De- crease		1900-1910 Per Cent. In- crease or De- crease		Acreage Av. Net Increase Per Cent.	Acre-Val. of Farm Products
	Acre- age	Acre Value of Farm Prod- ucts	Acreage	Acre Value of Farm Prod- ucts	Acreage	Acre Value of Farm Prod- ucts	Acreage	Acre Value of Farm Prod- ucts	1870-1910	Average Net Inc. Per Cent. 1870-1910
North Atlantic.....	8.75d	32.91d	18.32d	28.64i	24.25d	10.50d	10.81d	32.52i	15.53d	4.44i
Middle Atlantic.....	12.32i	28.80d	4.16d	7.48d	2.02d	9.34d	4.76d	27.21i	1.38i	6.14i
South Atlantic and Gulf.....	17.11i	23.04d	16.88i	22.96i	10.44i	14.55i	8.94i	5.17i	13.34i	2.33i
Central.....	32.60i	9.21d	10.25i	22.31d	11.11i	16.19i	27.95i	40.63i	20.48i	6.33i
North Central.....	46.09i	9.57i	19.75i	55.21i	16.91i	23.81i	6.52i	41.15i	22.31i	32.44i
Plains.....	81.28i	44.49i	57.37i	51.22i	23.85i	38.37i	31.68i	55.17i	48.54i	47.31i
Rocky Mountains.....	73.97i	40.47i	58.47i	50.87i	35.01i	30.31i	47.20i	66.60i	53.91i	47.06i
Pacific.....	43.63i	23.43i	23.96i	35.55i	6.36i	14.90i	14.91i	49.94i	22.21i	30.96i
General Average Net Increase.....									24.71%	22.12%

In the table above, the increase and decrease of both acreage and acre-yield, are placed on a percentage basis, and are therefore comparable each to each. If, therefore, the acre-yield from one decennial period to another had kept step with the acreage yield, the percentages of increase and decrease would be harmonic. This, however, is not the case. There is little or no correspondence between the two. If any harmony existed, it would certainly be shown in the general

ginia, comprising the upper Mississippi drainage basin, certainly pre-eminently the typical agricultural part of America, the average net percentage increase in farm acreage for the entire past generation has outstripped the corresponding net percentage increase in acre-products upon it by 14.15 per cent., it would seem proper for science to give the matter serious consideration and attention. In the Plains region, where improved methods of farming on dry-land areas, and the intro-

duction of better crops, such as alfalfa and the sorghums, and in the Rocky Mountain and Pacific regions, where irrigation is practised and higher-priced crops are grown, the percentage increase in acre-value of the products, equals or surpasses the percentage increase in acreage of the improved land.

Taking the evidence as a whole for the entire country, it appears from the general average at the foot of the last two columns, that in forty years the net increase in food production in the United States ran behind that of the land brought under cultivation by about two and one half per cent. In other words, the people on the farms failed to raise enough more products per acre, as measured by the average selling price, to correspond with the amount of land they were cultivating. That this is partly due to a falling off of agricultural labor is probable; that it is partly due to diminishing fertility from continuous cropping is measurably certain. It is likewise evident that this general situation has been arrived at in spite of the fact that the period in question, covers nearly the whole period of the rise and growth of the state agricultural colleges and experiment stations, and the development of the enormous activities of the United States Department of Agriculture, through all of which agencies, new and better systems of tillage, cropping and rotation, and feeding of farm animals, have been introduced and disseminated, all of which should contribute to operate toward counter-balancing the losses from the other sources.

If the agricultural situation has been thus detailed at some length, it is in order to bring out the vital fact that there is a definite demand upon science, and especially upon that part of science that is capable of dealing scientifically with at least some of the factors underlying plant production, to lend its aid to the relief of a situation that is becoming worse instead of better. This is the matter with which the agricultural colleges have to deal and which bears a vital relation to the teaching of botany.

So far as botany is concerned, the main problem from the educational standpoint is,

how can the young people in the public schools receive such a training and discipline as will be of scientific value, and at the same time be of vital economic use in their everyday life.

As a general social question, the problem is, how can this subject which can unquestionably be made of economic value, be so handled as not to destroy its integrity as a part of the teaching of science, and at the same time contribute its maximum help to agriculture. Now our principal business with secondary school pupils is not merely to give botanical discipline in an abstract sense, but to give such students as broad and as scientifically accurate a knowledge as possible of the only plants with which they are ever likely to deal, and from which the world gets its living. About ninety-five per cent. of high-school graduates go no further. Should effort be devoted to giving these immature minds a hasty and inadequate sketch of a botanist's realization of the plant world, or should we rather be contented with giving them that part of botany that will be most useful and necessary in their probable occupations. I think unquestionably the latter. We are certainly not precluded thereby from making botany a subject of disciplinary value. Charles Darwin was not a superficial student of plants, for the reason that he directed his studies to those phenomena which the seed plants alone offer to the unaided eye. After the pupil has thus built up a solid and substantial knowledge of the way in which the higher plants are constructed in their more obvious aspects, and how they perform their work, time should then be devoted to widening this plant horizon, by bringing in the lower groups in succession. But even here it is wise to avoid a strenuous attempt at a scientific discussion of the alternation of generations. The object, at this juncture, should mainly be to give the student an alga concept, a fungus concept, a fern concept and so on, that he need not go through life entirely ignorant of what these lower forms of plant life are, how and where they live, and their economic relation to the earth, especially of course to man.

It is not impossible to make plant evolution the central axis around which to swing a high-school course in botany. High-school pupils can be trained in this sort of discipline, but it usually involves the wooden adherence to a few "types" illustrating a supposed evolutionary series, and imposes severe limitations upon a student's conceptions of plants, no less detrimental in its effect upon his mind than the rigid conceptions of "typical" plants, and the stereotyped leaf and flower forms of the pseudomorphology of the older school. The phylogenetic method of teaching botany to elementary students, is not only objectionable because it deals with plants which are almost throughout entirely unrelated either to their previous experience and observation, or to their future necessities, but because, as ordinarily handled, the data are confined to a comparatively few type plants because of the time restrictions imposed. The result is, that instead of widening his horizon of the plant world, the succession of forms worked upon, serve chiefly as mnemonic beads in a botanical rosary, the telling of which serves to call up memorized facts for examination purposes, chiefly concerning reproduction.

At the present time, the teaching of botany in secondary schools is quite generally morphological in character, a survey of the general morphology and reproduction of the great groups of plants in succession. This is done partly by virtue of tradition, and partly because the subject is most easily handled in that way under average conditions. In too many cases however, this sort of teaching degenerates into a sort of stereotyped routine, revolving around the peculiar relations of the alternating generations in plants—the tragic story of the decline and fall of the gametophyte and the triumphant rise of the sporophyte. This rather extensive and various history has become condensed and standardized for teaching purposes into an orthodox version, to the correct rendition of which a few selected forms of plant life are annually consecrated. Beginning with the microscopic, unicellular forms of green algae, we proceed, with side excursions into the equally micro-

scopic blue-greens, up through colonies, flat, globular, and in chains and filaments, until we finally get to a real alga that we can plainly see with the 1/6 objective. From here on, the pathway leads finally to where *Fucus vesiculosus* and *Polysiphonia violacea* are waiting to tell their tale of the alternation of generations and heterospory. Once in the clutches of these two ideas, botanical anxiety for the student begins, for he is there to stay.

We are now, however, compelled to divert our attention for a time from green evolution in order to pick our way over the fungi, after which we duly return to our duty of securing the transition in the laboratory from water to land life, whereby there emerges, with dripping rhizoids, a liverwort upon the mud.

The Bryophytes, unfortunately, are still very small plants, and usually do not of their own motion excite undue interest among young people. However, this is not for us to discuss, to be sure, since it becomes our responsibility for the next few weeks, to make the curious and rather minute relations of the gametophyte and sporophyte series in this group the chief object of our ambition. There is many a beginning student who has been led during this period of his life to suppose that botany thinks a great deal of *Marchantia polymorpha*. Bidding farewell at length to the Hepaticæ, we become greatly obliged to the botanical supply company for its fruiting *Sphagnum* and its *Polytrichum commune*, whereby we are enabled to continue the ever-lengthening story of the everlengthening sporophyte and its ever-diminishing spores.

The leafy gametophyte of the Bryophytes has now to roll up its foliar organs and be born again like unto a liverwort, re-emerging before the student as the prothallium of the ferns. We have now at last gotten roots on the sporophyte, and its future is assured, so that we can henceforth proceed to devote our remaining attention to prosecuting our favorite microscopic pursuit of the luckless and reticent gametophyte, as it elusively recedes from form to form, through *Marsilia*, *Salvinia* and *Pinus Laricio*, until its final recondite

demise in *Lilium Martagon*, and the last "slide" is "drawn."

Is this a caricature? No more so than many such a course is a caricature of reality in the plant world. The question is, does it pay, with the limited time usually available, to sketch hastily through a syncopated genetic series in secondary school work. The primary object in following such a series through, is to get before the student a picture of the upgrowth of the sporophyte form, which is the final stage in morphogenetic evolution in plants, and through the facts in reproduction, throw light upon the evolutionary relationship of the various phyla.

To this end, beginning students who have usually observed little with their eyes, have to be armed at the very outset with the dubious weapon of the compound microscope, and their first weeks in botany are consecutively devoted to an examination and study, almost entirely through the microscope, of organisms that the most favorably disposed among them are hardly prepared to appreciate as plants. From the pedagogical standpoint this is a weak approach. If however, instead of the groups of the Thallophytes, and the succeeding members of the evolutionary series, the seed plants are made from the outset the center of gravity of the teaching, the interest and sympathy of the students is more easily impounded. If this method is followed, it is desirable, instead of beginning with a study of seeds and seedlings and so on, to commence with a complete life-cycle exercise covering the entire life history of the species, from the seed on to maturity and seed reproduction. This can be done by means of a serial succession of plantings made in advance, whereby the student gets at once at a given laboratory period, an immediate present view of all the stages through which the plant has had to pass. Lima beans, for example, handled in this way, will give satisfaction, and, in the final stages, will furnish a complete series in the plant's reproduction, from unfertilized flowers on to well-grown seed pods upon the same plant. All the morphological details of structure of all the different organs may be worked out at once upon

such a plant, and many species may be introduced in series in the same manner for comparative study of types of development. The morphology however, it ought to be emphasized, should be accompanied step by step, by experiments in the physiological behavior of the same organs. Osmosis experiments should accompany the study of roots and root-hairs, and not be postponed to some future exercise in physiology. Transpiration and photosynthesis experiments should be conducted simultaneously with the study of the leaves as such. Conduction should be studied experimentally, at the same time with the study of the structure of stems. The rate of growth of stems and roots, and of the floral organs before and after fertilization, should be determined while the students are engaged at the same time upon the morphology of those structures.

It is a useful and practical thing, when dealing with the structure of leaves, for example, to take plants in which there is a considerable deposition of reserve food, such as corn, potato, sweet potato, etc.; in warmer regions, taro, sugar cane and banana, and have the pupils determine for the entire plant, the total percentage amount of combustible dry matter, taking the storage regions separately as such. By separately determining the total percentage amount of water, dry matter and ash, the work of the plant as a machine in the manufacture of carbohydrates can be plainly seen. If the area of the leaves is now measured, the number of grams of carbohydrates produced per unit of leaf surface can be calculated, and this in turn can be converted into terms of energy in calories. If such an exercise as this, together with field work in leaf ecology, accompanies the study of palisade cells, stomata and conduction tissues in leaves, the latter will be seen in the light of functioning organs, and not as static structures. There seems to be no disputing the fact that the study of the structure of organs will be vitalized, by experimental work alongside at the same time upon their functions. It is correspondingly useful, for example, while engaged in the study of the structures of reproduction, to have the pupils demon-

strate for themselves, as with such plants as corn, wheat, beans, or the more common prolific weeds, the volume and extent of their reproductive energy, as measured by the number and amount by weight of their seeds. The relative prolificacy of representatives of tested varieties of the same cultivated species, such as soy beans and cow-peas, may be used for a comparative study of the relative expenditure of vegetative and reproductive energy. If plants in flower are accessible, such as can easily be hand-pollinated, such as corn, cotton or tobacco, many of the fruit trees, garden geraniums, etc., the time elapsing between pollination and the first signs of fertilization should be ascertained experimentally. Such experiments as these, combined with field experiments in cross and close fertilization and in the study of the adaptations thereto, vitalize for the pupils the whole study of the structures of reproduction, and of the scientific aspects of the reproductive process.

In fact, throughout the whole elementary botany course, every possible effort should be made to illustrate immediately, structure by function and function by structure, and to bring out the variations in structure which accompany variations in function under different habitat conditions. Students should be led especially to study the biological adaptations of plants to their environment in their own neighborhood. If some study of plant evolution is lost in doing this, the gain will be compensatory, since the pupils will come to realize that plants are vital and very variable biological organisms, with various dynamic activities, and not "typical" static structures, chiefly engaged in reproduction.

In any event, a beginning course in botany should strive to give students some conception of the luxuriance, richness of material, riotous abundance in color and form, and marvellous complexity of structure and adaptation which is the reality of fact in the plant world, instead of leaving him with a conception of pettiness in the materials offered, of triviality in the functions performed, and of dryness and stiff formality in the relationship, of the organisms. One way in which to avoid the sense of pettiness which

well-grown students not infrequently experience in being set to work upon the lower and smaller forms of life, is to increase greatly the number of forms and types for general comparative habit-study. In working with algae for example, a considerable supply of a wide variety of fresh-water forms collected locally, supplemented from a marine supply company, by as large an assemblage of species of the larger marine algae as can be afforded, coupled with a study of the use of the latter for food, fertilizers, etc., will do more for the student educationally than an intensive study of a few, unfortunately for the most part, species of insignificant size and of lesser economic importance. In the study of the lower forms, *it should be made a general policy throughout*, to secure for habit study a large variety of species of the forms worked with, in order to give the students, to some extent at least, a comparative, conception, a broader mental idea, of the groups taken as a whole.

In the study of the fungi, a secondary school course in botany should consist mainly in a study of plant diseases, with enough experimental work in growing cultures of important pathogenic organisms at least, to teach the student the nature of the invading fungi. That such a course can comprise all the forms necessary to include the various types of fungus morphology and spore reproduction, is sufficiently manifest. A course of this kind should leave the pupil knowing most of the commoner diseases of the ordinary farm, orchard and garden plants, and their means of prevention.

Such a rapid survey of the lower groups of plants, systematic rather than morphological in character, should likewise be followed by a systematic study of the more important orders and families of the seed plants. The work should here be more intensive than with the lower groups, for here is the opportunity to present in orderly sequence, in something of a connected series, the extraordinary array of the economic plants. All of the principal agricultural, forest and garden plants, the wild flowers, the poisonous species, the drug plants, and the weeds of the farm and the wayside, can now be thrown into orderly

sequence, as their representatives are brought into the laboratory for study. No course in botany for high-school students ought to be considered satisfactory, that does not give a tolerably good idea of the relationships of the principal families of the seed plants, of the place of the economic plants among them, and of their geographic and ecological distribution.

Toward the close of the year, and after the systematic work referred to, some simple work in the study of variation, and of the results of selection should be taken up. There is no better way of developing observation in young people, than by setting them to work collecting all the so-called "variations" they can find of a number of species of plants. A little simple work in plotting variation curves is also easily possible with high-school students. A school garden can be made to afford a series of plants to be used in hybridization, and the pupils can readily be taught the necessary technique in plant breeding. Curiosity once aroused as to the outcome of crosses, and interest awakened in the possibility of originating new forms of plants, the high-school teacher will find such a summer occupation for the brightest pupils as may lead to serious and important results. Many a student in a farm neighborhood will be aroused thereby to undertake valuable work in the improvement of staple crops, such as will bring about economic results of value to an entire neighborhood. It is also perfectly easy to convey to pupils of this age a working knowledge of the elementary principles of breeding, sufficient to serve for a considerable range of practical purposes.

We may therefore conclude that a course in agricultural botany for secondary schools should differ from the ordinary academic course in the same subject in the following respects:

First, in the aim of the course, which is the economic advantage of the pupil rather than the professional array of the subject from the standpoint of discipline.

Second, in the means used for botanical instruction, the seed plants being largely em-

ployed as teaching material for practical purposes.

Third, in the extensive use of plants of economic value as the means through which to study plant structure and functions.

In the hundreds of cultivated forms of grasses and forage plants, in the multitude of varieties of the grains, in the horde of the vegetables, in the manifold fruit-bearing plants of the orchards and gardens, in the wealth of valuable forest trees, ornamental garden plants and shrubbery, in the array of plants grown for fibers, for drugs, gums, resins, rubber, beverages, condiments, and spices in the parasites, poisonous and noxious plants and weeds, there exists a vast botanic garden of species, varieties and biotypes of plants, wild and cultivated, in which every modification of form, and every biological adaptation of structure to environment is found. There is no type of root, stem, flower, or seed structure, generalized or specialized, that is not to be found among them. There is no mode of securing or preventing cross or close pollination which they do not exhibit. There is no mode of performance of a single physiological function in any type of habitat that they do not display. In this maze and medley of plants cultivated by man, and which carry the initial intrinsic interest of economic value, are limitless opportunities for developing in a beginning course in botany, fresh and interesting types of material for the study of the organs and tissues of plants, their work and their relation to soil and climatic environment. Here is the high school's, and especially the rural high school's opportunity in botany.

In all communities, and especially in rural communities, a course in botany should have three fundamental objects—to stimulate observation, to give such botanical knowledge and training as will be most useful, and to impart culture. Let us briefly consider these three leading motives.

First, as to the matter of observation. Our public school system is overburdened with second-hand learning. Ideas are furnished ready-made in books. The written word becomes a fetish. The child gets most of his

notions of the universe by reading what somebody else has said about it. Everything has to be subordinated to getting large masses of pupils "through the grades." The simplest way to do this is to cause large quantities of ready-made, predigested information to be memorized, recited upon and "passed" in examination. Originality, curiosity, spontaneity, are all effectually stamped out by this process, and the child, who is naturally an investigator to begin with, becomes in the end a mere passive recipient of prescribed orthodox information.

It is the duty of the biological sciences to step into the school room, reawaken this latent curiosity, and fan the sparks of originality into the flame of investigation. Can this best be done by a course in botany that is "scientific" from the adult standpoint, but that is totally lacking in vivid human interest from the point of view of young people. Shall we stimulate observation in eyes already grown accustomed to looking for the world in print, by carrying them still farther away from the domain of sense experience. we must compel young people to realize the vast range of nature about them that their eyes should be open to see. We must lead them first up to the plants, and only afterward inside of them. Does any one who has ever worked with young students, doubt for a moment that one of the surest ways of arousing and holding their interest in the plant world, is to open up new vistas of knowledge to them in those many plants which already claim the world's interest because of their usefulness or beauty.

So far as the teaching of botany as an observational subject is concerned, it is possible to say from personal experience, that the use of the straight observational method in an ordinary laboratory of elementary botany, conducted entirely without the use of any laboratory guides or outlines whatsoever, has proved an entirely successful experiment. The plants were placed before the students, with instructions to find out, first with the eyes, then with the simple microscope, and finally with the compound microscope, all that they could discover about them that

seemed in any way characteristic, and afterwards to describe what they had observed, both in writing and by sketches, in extent, measure and proportion as they saw fit, being held responsible for getting results, but not for the manner or form of getting them. It is surprising what an amount of spontaneous observation, original in form and substance, was evoked by this method. It can be confidently asserted that public-school pupils just entering the high school, or high-school students just entering college, and spoiled for original thinking and observation by the continual taking of notes and following of outlines, can be taken in hand by this method and trained to observe nature.

Secondly, with regard to the imparting of such botanical knowledge as will be most useful, it would scarcely seem to demand discussion, that for the majority of secondary-school pupils, that botanical training is most desirable which gives them the greatest possible amount of knowledge which can be made practically serviceable. The relation of plant physiology and structure to agriculture and horticulture, plant diseases, medicinal plants, weeds and their eradication, plant breeding, the botanical relationships of the chief families of the seed plants, and especially of the economic plants, are fields in botany that can be drawn upon for teaching purposes with the greatest profit.

A broader knowledge of the species and varieties of economic and ornamental forest and fruit trees, wild and cultivated, and of the wild and cultivated ornamental flowering plants, will also lead to an interest in introducing and growing many new and attractive forms of plant life in the community, and in the consequent adornment of homes monotonously devoid of variety and beauty.

Finally, as a means of enlightenment and of imparting culture, botany is a sadly neglected field. Between the teachers with ultra-scientific proclivities and propensities, and those who are frank agronomists, the obvious opportunities of botany in the humanistic field have been extensively overlooked. The history of the origin and migrations of the cultivated plants, and the discovery and use

of plants in primitive culture for food, clothing and household purposes, leads directly into the domain of human history and anthropology.

The study of the origins of the names of plants and their folk-lore, in connection with the literature of wizardry, magic, necromancy, the healing art and poetry, furnishes an abundance of material of decided human interest and value.

The study of the plant as a machine, in the light of its adaptations of structure to habitat, to secure survival, and to effect fertilization and the distribution of seeds and spores, in its economy in the use of material, and in its conservation of resources, is a field of distinctively cultural value. Certainly the field study of the struggle of plant societies with one another for existence and for supremacy, and with their general biological and physical environment, furnishes material for thought, analogous to the study of social evolution, and from which social lessons can be derived.

Without in any way cheapening its disciplinary value as science, a great opportunity is thus open to elementary botany, of becoming a subject of far more practical value, interest and importance, both in the field of education, and in the development of agriculture.

HERBERT F. ROBERTS

UNIVERSITY OF MANITOBA

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**GRANTS FOR RESEARCH OF THE  
AMERICAN ASSOCIATION FOR  
THE ADVANCEMENT OF  
SCIENCE**

AT the annual meeting of the association in 1918 the Committee on Grants for Research was organized for the year 1919 as follows: Henry Crew, Chairman; N. L. Britton, W. B. Cannon, J. McK. Cattell, R. T. Chamberlin, L. I. Dublin, G. N. Lewis, G. H. Parker and Joel Stebbins, Secretary. The sum of four thousand dollars from the funds of the association was assigned by the council to the committee for distribution in support of investigations. The committee

did not hold a formal meeting, but transacted all of its business by correspondence, and by the middle of June had distributed the entire sum at its disposal in the following grants.

#### *Astronomy*

Five hundred dollars to Professor E. B. Frost, of the Yerkes Observatory, for the securing, measurement and reduction of stellar spectrograms. Additional assistance in this work with the 40-inch telescope will greatly increase the mass of results being accumulated concerning the motions of stars.

#### *Physics*

One hundred and fifty dollars to Professor A. L. Foley, of Indiana University, for experiments on the speed of sound very close to the source. This investigation is in extension of the important and rather remarkable results which Professor Foley has recently published in the *Physical Review*.

One hundred dollars to Professor Orin Tugman, of the University of Utah, to meet the cost of a monochromatic source of light to be used in finding the change of conductivity in a thin metallic film when exposed to ultra-violet light—a problem which has acquired new importance in view of the rapidly developing electronic theory.

One hundred and fifty dollars to Professor E. M. Terry, of the University of Wisconsin, for work on the modulation of radio-energy employed in wireless telephony.

One hundred dollars to Professor F. C. Blake, of the Ohio State University, for aid in prosecution of a study of electric waves and dielectric constants.

#### *Chemistry*

Three hundred and fifty dollars to Dr. Gerald L. Wendt, of the University of Chicago, for the investigation of the photochemical reactions of hydrogen and chlorine. He has been able to show that under the action of alpha rays and in the vacuum discharge tube hydrogen forms a chemically very active form, which probably has the formula  $H_3$ . From a valence point of view

the existence—and even more so the properties and the method of formation—of this gas are of great interest. There is some evidence that chlorine is also activated by exposure to light, but the evidence is contradictory. The mechanism of the effect of ultra-violet radiation on chlorine, including the possibility of the existence of an ozone form of chlorine, will be investigated.

#### Geology

Two hundred and fifty dollars to the Seismological Society of America to enable the society to dispatch capable men to study the phenomena of earthquakes as promptly as possible after their occurrence. When an important earthquake has occurred a delay of even a few days in sending an experienced seismologist to the locus of the quake will usually mean that many important pieces of evidence have deteriorated in value or have been wholly destroyed. This grant has been made in recognition of the urgent need of the Seismological Society for a sum available for immediate use whenever there occurs an earthquake which promises to give important results.

Two hundred dollars to Dr. Roy L. Moodie, for the preparation of sections of fossil bones which show lesions of ancient disease, and for the making of photomicrographs of these sections. Dr. Moodie, by a careful study of the bones of ancient vertebrates, is succeeding in tracing many present diseases far back in the geological record. These discoveries which are opening up a new field—paleopathology—are arousing much interest both among geologists and among the members of the medical profession.

#### Zoology

Five hundred dollars to Professor C. H. Eigenmann, of Indiana University, to defray part of the expenses of the Irwin expedition to western South America. The object of this expedition was to collect the fresh-water fishes from parts of Peru, Bolivia and Chile and thereby to supply the necessary material for the study of important faunistic questions.

Two hundred dollars to Dr. P. W. Whiting, of Franklin and Marshall College, for investigations on the Mediterranean flourmoth and its hymenopterous parasite, hadrobracon. The money is being spent for cytological equipment, breeding boxes, and apparatus for control of temperature and humidity. The work has thus far been carried on at the Marine Biological Laboratory, Woods Hole, Massachusetts, and at Lancaster, Pennsylvania. Somatic and germinal variations, sex determination, and sex ratio are being investigated.

#### Botany

Five hundred dollars to the editorial board of *Botanical Abstracts* for aid in establishing this new and important periodical, which has already met with much success and provides a long-needed method of bringing the current results of botanical investigation to the service of a great number of students.

One hundred dollars to Dr. Gilbert M. Smith, of the University of Wisconsin, for aid in a study of the plankton of the lakes of southwestern Ontario.

#### Anthropology

Two hundred dollars to Dr. Aleš Hrdlička for *The American Journal of Physical Anthropology*. Dr. W. H. Holmes, head curator of the department of anthropology of the U. S. National Museum, wrote as follows: "Referring to Dr. Hrdlička's request for financial aid in the publication of the *American Journal of Physical Anthropology*, I take the liberty of seconding his request. The *Journal* fills a very important place in the field of anthropological science and is in the hands of our ablest students of this branch. The facts that at first the patrons of the *Journal* are necessarily limited in number and that the expenses of publication are just now nearly doubled will, I am sure, enlist your sympathy, and I sincerely trust that you may find it possible to lend the doctor a hand."

#### Social and Economic Science

Two hundred dollars to Miss Myra M. Hulst, of New Haven, Connecticut, for in-

vestigations into the mortality of graduates from American colleges for women. Miss Hulst reports that she has completed the mortality rates for graduates from Smith and Vassar and that she has nearly completed the tabulation of the records for Wellesley College. Preliminary results indicate that graduates from women's colleges enjoy extraordinarily low death rates, consistent with their favorable economic and social status. The research was recommended by Dr. Dublin, under whose direction it is being carried on.

### Medicine

Four hundred dollars to Dr. Leslie B. Arey, of the Northwestern University Medical School, in support of his study of the origin, growth and fate of the giant cells, or osteoclasts, usually held responsible for bone dissolution. It has been found that osteoclasts arise chiefly by the fusion of depleted bone-formative cells, the osteoblasts; they further increase by taking to themselves osteoblasts and bone cells, but ultimately degenerate and disappear. There is no convincing evidence that osteoclasts are the specific agents of bone resorption. That they are degenerating, fused osteoclasts accords better with the known facts.

### Education

One hundred dollars to Dr. S. A. Courtis, Detroit, Michigan, toward the expenses of securing a comparison based upon a survey of Boston schools in 1845 with present-day schools from Maine to California.

JOEL STEBBINS,  
*Secretary*

### SCIENTIFIC EVENTS

#### THE BRITISH ASSOCIATION AND SCIENTIFIC RESEARCH

PROFESSOR JOHN PERRY, treasurer of the British Association, made some remarks before an evening discourse on September 11, at the recent Bournemouth meeting of the association which he summarizes for *Nature* as follows:

After paying printing and office expenses, the funds of the British Association are devoted to

scientific research. For more than eighty years we have spent more than £1,000 a year on research, long before ordinary people had heard of research.

Every year we form many research committees; each of them is formed of the foremost men of science of Great Britain, who receive none of the money themselves, and their accounts for mere out-of-pocket expenses are carefully audited. These researches in the past have created some entirely new sciences, have led directly and indirectly to the creation of many new industries, and they have largely produced the world's present natural knowledge. And now to my point. Yesterday a very prominent member of the association asked me about our finances. I had to admit that even before the war we were meeting with difficulties due to the increased cost of printing, and other things, that since the war we have been behind-hand to the extent of more than £1,000 every year, and that we have never yet asked for the help of moneyed men. The only gift we have ever received from a moneyed man was a voluntary gift from Sir James Caird, who handed me £11,000 at the Dundee meeting. My questioner said we ought to ask for help, and that he was willing to start a fund with a sum of £1,000. At this moment he does not wish to have his name mentioned.

I need not dwell on the importance of our research work, as I feel sure that every person here who has himself done original work shares my opinion that when we limit our expenditure on research, and especially on pure scientific research, we shall begin to be a bankrupt association—bankrupt, that is, morally from the point of view of science, if not actually in the financial sense.

The moneyed men of Great Britain are most willing to help any good object when they get proof that it really is a good object. We can not complain of want of their help, for they did not know the facts. At the same time, the treasurer of an association with such a record as ours does not feel happy at the prospect of begging for help.

In the two days of the meeting following that on which I made this statement, the fund was raised to a total of £1,475. I intend to publish in due course a list of names of donors and donations.

To illustrate by many instances (as I might) our claims as to the importance of our researches would unduly prolong this letter, and any selection of a few examples would be unrepresentative. I will cite a single illustration: The National Physical Laboratory, the scene of researches of which the importance to the nation during the war and earlier can not be overestimated, had its origin

(if its antecedents be traced backward) in the Kew Observatory, which was maintained by the British Association from 1842 to 1872, in which period the association spent some £12,000 on its upkeep.

#### THE WORK OF THE NATIONAL COMMITTEE ON MATHEMATICAL REQUIREMENTS

A PRELIMINARY report of "The Reorganization of the First Courses in Secondary School Mathematics" prepared by the subcommittee, which was authorized to publish it was issued on November 25. It is being made the basis of discussion by organizations, committees, local groups, etc., throughout the country. Over 30 such organizations are at present at work on this report.

The whole of the meeting of the Association of Teachers of Mathematics in the Middle States and Maryland in Philadelphia on November 29 was devoted to the discussion of this report; it had a prominent place on the program of the Central Association of Science and Mathematics Teachers in Chicago on November 28 and 29 and at the meeting of the Association of Teachers of Mathematics in New England in Boston on December 6.

Committees representing organizations in the following states are actively cooperating with the National Committee: Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, West Virginia, Ohio, Indiana, Illinois, Wisconsin, Iowa, North Dakota, Missouri and Texas.

Local groups or clubs are studying the report in Boston, Springfield (Mass.), Providence, New Haven, New York City, Washington, Baltimore, Cincinnati, Columbus (Ohio), Terre Haute, Chicago, St. Louis, St. Paul, Minneapolis and in several smaller cities.

Meetings in addition to those previously announced at which the work of the National Committee will be discussed are as follows: Mathematical Association of America in St. Louis, December 29 and in New York, January 2; Ohio State Teachers' Association, Columbus, December 30; Pennsylvania State Educational Association, Philadelphia, December 30; Association of Teachers of Mathematics in the Middle States and Maryland, Southern Section, Baltimore, December 13,

Syracuse Section, Syracuse, New York, December 30.

The next meeting of the national committee will occur in New York City on December 30. The principal items on the program for this meeting are the consideration of the report on "The Reorganization of the First Courses in Secondary School Mathematics," the report on "The Valid Aims and Purposes of the Study of Mathematics" and the proposed revision of college entrance requirements.

The United States Bureau of Education has offered to publish the reports of the National Committee in the form of leaflets or bulletins.

A Mathematics Section of the West Virginia State Teachers' Association was organized in Fairmont on November 28. Professor John Eiesland, of the University of West Virginia, was elected chairman of the newly formed Section. Professor C. N. Moore spoke in behalf of the work of the National Committee.

#### CHEMICAL LECTURES AT WEST POINT AND ANNAPOLIS

THE American Chemical Society has arranged a series of lectures on the relations of chemistry to problems of interest in cadets of the United States Military and Naval Academies. The lectures to be given at West Point are as follows:

Dr. Wm. H. Nichols, New York City. Sulfuric acid, the pig iron of chemistry. January 10, 1920.

Dr. Wm. H. Walker, Massachusetts Institute of Technology, Cambridge, Mass. Manufacturing problems of gas warfare. January 17, 1920.

Dr. Chas. L. Parsons, 1709 G St., N.W., Washington, D. C. Nitrogen fixation and its relation to warfare. January 24, 1920.

Dr. Henry Fay, Massachusetts Institute of Technology, Cambridge, Mass. The amorphous state in metals. January 31, 1920.

Dr. Chas. L. Reese, E. I. du Pont de Nemours & Co., Wilmington, Del. Explosives. February 7, 1920.

The lectures at Annapolis are:

Dr. Henry Fay, Massachusetts Institute of Technology, Cambridge, Mass. Iron and steel. November 15, 1919, to post-graduate student officers.

Dr. John Johnston, Yale University, New

Haven, Conn. The utilization of research. December 13, 1919, to post-graduate student officers.

Dr. Arthur D. Little, Charles River Road, Cambridge, Mass. Natural resources in their relation to military supplies. January 17, 1920, to post-graduate student officers.

Dr. Wm. H. Nichols, 25 Broad St., New York City. Sulfuric acid, the pig iron of chemistry. February 6, 1920, to midshipmen.

Dr. Willis R. Whitney, General Electric Co., Schenectady, N. Y. Industrial research. February 7, 1920, to post-graduate student officers.

Dr. W. Lee Lewis, Northwestern University, Evanston, Ill. Organic research in toxic gases. March 6, 1920, to post-graduate student officers.

Dr. Chas. L. Reese, E. I. du Pont de Nemours & Co., Wilmington, Del. Explosives. April 2, 1920, to midshipmen, April 3, 1920, to post-graduate student officers.

Dr. Wilder D. Bancroft, Cornell University, Ithaca, N. Y. Organized research. April 30, 1920, to midshipmen, May 1, 1920, to post-graduate student officers.

Dr. Wm. H. Walker, Massachusetts Institute of Technology, Cambridge, Mass. Manufacturing problems of gas warfare. May 15, 1920.

#### SCIENTIFIC NOTES AND NEWS

A SECTION of engineering has been established in the National Academy of Sciences and is now constituted as follows: Messrs. H. L. Abbot, J. J. Carty, W. F. Durand, J. R. Freeman, H. M. Howe, F. B. Jewett, G. O. Squier, D. W. Taylor. All members of the sections of physics and chemistry were given an opportunity to remain with the section with which they had been affiliated or to be placed in the section of engineering.

AT a recent meeting of the corporation of Yale University it was voted "to extend the sincere congratulations of the corporation to Professor Ernest Brown on the completion of his monumental work on the "Tables of the Motion of the Moon," and to assure him that the university considers the work that he has done on these volumes as among the most important scientific contributions ever made by an officer of Yale University."

WE regret to learn that Sir William Osler, regius professor of medicine in Oxford Uni-

versity, who passed his seventieth birthday anniversary last July, was stricken with pneumonia in November.

SIR HENRY A. MIERS, vice-chancellor of the University of Manchester, and formerly professor of mineralogy at the University of Oxford, has been elected president of the Manchester Literary and Philosophical Society.

THE Royal Meteorological Society has awarded the Symons memorial gold medal for 1920 to Professor H. H. Hildebrandsson for distinguished work in connection with meteorological science.

DR. A. PIRELLI has been elected president of an Italian Society of Chemical Industry which has been organized at Milan.

DR. J. C. McLENNAN, professor of physics in the University of Toronto, who has since 1917 been engaged in work for the British Admiralty, will shortly return to Toronto.

DR. NELSON W. JANNEY, New York City, has been appointed director of the new Memorial Laboratory of the Santa Barbara Hospital, founded by the late Dr. Nathaniel Bowditch Potter, for research on metabolic diseases.

DR. RALPH B. SEEM, Baltimore, assistant superintendent of the Johns Hopkins Hospital, has accepted the position of superintendent of the Billings Memorial Hospital, Chicago.

MR. CHESTER G. GILBERT has resigned from the Smithsonian Institution to accept a position on the staff of Arthur D. Little, Inc., of Cambridge, Massachusetts, which has opened a Washington office in the Munsey Building, with Mr. Gilbert in charge.

DR. E. MILLER, associate in chemistry at the Johns Hopkins University, has resigned to take a position with the DuPont Powder Company.

MR. W. J. COTTON has resigned from the color laboratory of the Bureau of Chemistry to accept a position with the National Aniline and Chemical Company, of Buffalo, New York.

WE learn from *Nature* that Captain P. R. Lowe has been appointed assistant in charge of

the bird-room at the Natural History Museum in succession to Mr. W. R. Ogilvie-Grant. Captain Lowe has for many years devoted himself to ornithological research at the Natural History Museum, the Royal College of Surgeons, and Cambridge University, and has made extensive collections of, and observations on, birds in Madeira, the Canaries, the Azores, the Cape de Verde Islands, the West Indies, Mexico, Florida, the Mediterranean islands and coasts, South Africa and the British Islands.

DR. JOSEPH T. SINGEWALD, JR., professor of economic geology at the Johns Hopkins University, has been granted leave of absence to carry on geological investigations in northwest Peru. He will sail from New Orleans on December 20.

ASSOCIATE PROFESSOR FREDERICK STARR, of the department of sociology and anthropology at the University of Chicago, who is now in Japan on a research expedition, will return to the university in time to give in January a series of illustrated lectures on Mexico.

To express the admiration and gratitude in which Dr. George M. Kober is held by his pupils, friends and coworkers, it has been decided to issue as a testimonial to these sentiments an anniversary publication dedicated to him, on the occasion of his seventieth birthday, March 28, 1920. George Tully Vaughan has been elected chairman of the organization; Felix Neumann, of the Army Medical Museum, secretary; John Foy Edson, treasurer, and as members of the committee at large, General Robert E. Noble, Drs. Charles D. Walcott, Wilfred M. Barton, J. W. Fewkes, Walter D. Hough, L. O. Howard, Aleš Hrdlička, T. Michelson, W. H. Holmes and N. M. Judd. The anniversary publication will be the issue of the *American Journal of Physical Anthropology*, which will be published in the latter part of March, and will be known as the George M. Kober anniversary number.

THE annual Mellon lecture of the Society for Biological Research of the University of Pittsburgh will be delivered by General W. C. Gorgas on the evening of January 8. The sub-

ject of the address will be "Yellow fever." General Gorgas is chairman of the Yellow Fever Commission of the International Health Board, Rockefeller Foundation, and has just returned to the United States from an extensive trip through Central and South America. In his address he will describe the present plans and progress of the work on yellow fever.

PROFESSOR WM. E. RITTER, director of Scripps Institution for Biological Research, visited the University of Illinois December 2 and 3. He spoke before the graduate students and faculty on "Research Problems and Facilities of the Scripps Institution." The department of zoology tendered him a dinner at which he led a discussion on marine biology.

DR. E. G. CONKLIN, professor of zoology at Princeton University, lectured on December 3 at Mount Holyoke College on "Has human evolution come to an end?"

THE Boyle lecture was delivered by Professor A. Keith on November 19, at Oxford University, on "Race and nationality from an anthropological point of view."

THE Harveian festival has been celebrated with full honors by the Royal College of Physicians of London, for the first time since 1913. The oration was delivered by Dr. Raymond H. P. Crawford, and dealt with the forerunners of Harvey in antiquity. After the oration the president presented the Baly Medal to Dr. Leonard E. Hill.

As a memorial of Professor J. Dejerine, Madame and Mlle. Dejerine have placed a fund at the disposal of the Paris Society of Neurology for research in neurology.

LOUIS VALENTINE PIRSSON, professor of geology in the Sheffield Scientific School of Yale University, died in New Haven, on December 8, at the age of fifty-nine years. Professor Pirsson had held the chair in physical geology since 1897, and for the same period was associate editor of *The American Journal of Science*.

JOHN TAPAN STODDARD, professor of chemistry at Smith College since 1878, died on December 9.

DR. ALLAN McLANE HAMILTON, at one time professor of mental diseases in the Cornell Medical College, died on November 23, aged seventy-one years.

THE death is announced at the age of seventy-eight years of Dr. Walter Knorre, long an astronomer at the Berlin Observatory.

DETAILED accounts of the railroad wreck in the Engo forest, Belgian Congo, in which Dr. Joseph R. Armstrong and William Stowell, both of Los Angeles and members of an exploring expedition sent out by the Smithsonian Institution and the Universal Service motion picture company, were killed have been received from railway headquarters in Rhodesia. The expedition left Sakania, Belgian Congo, for Elizabethville in a special coach attached to a freight train. While the train was stopping for fuel a water truck broke away and crashed into the rear of the train.

A CONFERENCE of representatives of the State and Local Academies of the Central States will be held at St. Louis in connection with the meeting of the American Association for the Advancement of Science. Officers of the academies are requested to meet at the Soldan High School at one thirty on Monday, December 29. Professor H. B. Ward, of the University of Illinois, whose address at St. Louis will be Hotel Statler, will be ready to give further information concerning the conference.

THERE will be a joint dinner of members of Section A of the American Association and of the American Mathematical Society on Tuesday, December 30, at 6.30 P.M. in the American Hotel Annex, 6th and Market Sts. The cost per plate will be \$1.50. Those who will attend are requested to notify Professor W. H. Roever, Washington University, St. Louis, before December 26.

THE twelfth annual meeting of the American Institute of Chemical Engineers was held in Savannah, Ga., December 3 to 6. A series of papers and addresses devoted particularly to such southern industries as cotton, turpentine and rosin was presented, and excursions

to the various chemical industries of Savannah and the vicinity were made.

As December 20, 1920, is the centennial of the Academy of Medicine at Paris, a committee of six members was recently appointed to have charge of the celebration of the anniversary.

THE Geological Survey of Great Britain and Museum of Practical Geology, Jermyn Street, S.W., have been transferred for administrative purposes from the Board of Education to the Department of Scientific and Industrial Research as from November 1, but correspondence with reference to the work of the Survey should be addressed as hereofore to the director of the survey and museum, Jermyn Street, S.W.

THE Agricultural Experiment Station *Journal* states that an announcement was recently made in the British parliament of a change in policy in 1918 regarding research in entomology and plant pathology through public funds. These subjects were originally allocated to the University of Manchester and the Royal Botanic Garden at Kew, respectively, with grants from the Development Fund for their support. In 1918, however, the Development Board decided that all research in plant diseases, whether due to insects or fungi, should be concentrated at a single phytopathological institute at Rothamsted, where also the board's scientific advisory staff in the subject would be stationed. Accordingly the staff at Manchester and a portion of the mycological staff at Kew were transferred to Rothamsted. A grant of \$5,000, per annum, was however continued to the University of Manchester to maintain certain phases of its entomological work and also to take up work in mycology there.

CAPTAIN WILLIAM C. VAN ANTWERP has given \$5,000 to the California Academy of Sciences, to meet the cost of one of the large habitat groups of California mammals which the academy is installing in its museum in Golden Gate Park. Captain Van Antwerp recently visited the museum and was so delighted with the beauty of the groups already

installed and so strongly impressed by their scientific and educational value, that he at once expressed the wish that he might be permitted to assist the museum in its efforts to be of service to the public. After conference with Dr. Evermann, director of the museum, Captain Van Antwerp selected the Roosevelt elk group as the one that he would like to finance. This group is now being prepared under Dr. Evermann's supervision. Paul J. Fair is installing the group and Charles Bradford Hudson is painting the background. The animals will be shown at the edge of a heavy redwood forest such as is found in their natural habitat in the northwestern part of California.

THE erection of a new building for the Department of Health in New York City has been made possible by an appropriation of \$1,000,000 granted by the Board of Estimate. The new building will be erected on a plot of ground, 100 x 100 feet, on West Thirtieth Street, between Seventh and Eighth Avenues. It will provide space for the offices of the director of the Bureau of Hospitals and for the director of the Bureau of Laboratories. Three or four floors will be given to the laboratories. The first floor will be for the Bureau of Records and another floor will be a modern health station where clinical work will be done. One floor will also be devoted to a medical library.

THE *Journal* of the American Medical Association states that the Reale Accademia delle Scienze of Turin, Italy, announces that the Vallauri prize of 26,000 lire, is to be awarded for the best work on any of the physical sciences that was published in the four years ending December 1, 1918. The prize is open to foreigners as well as to Italians. The works sent in to compete for the prize must reach the Academy Via Po 18, Turin, before December 31, 1919. A further prize of 1,200 lire is offered for the best manuscript or article published since January 1, 1915, on the etiology of endemic cretinism.

WE learn from the *Journal* of the American Medical Association that a new hygienic lab-

oratory provided with the most modern equipment has been recently inaugurated at Valparaiso, Chile, in connection with the hospital of San Juan de Dios. The laboratory comprises sections devoted among others to bacteriology, chemistry and serum manufacture.

IT is stated in *Nature* that the British Ministry of Ways and Communications Bill was read a third time in the House of Commons on July 10. Sir Eric Geddes, the minister-designate, announced the names of the prospective heads of departments as follows: *Civil Engineering*: Sir Alexander Gibb, civil engineer-in-chief, Admiralty, 1918. *Mechanical Engineering*: Lieutenant-Colonel L. Simpson, R.E., chief mechanical engineer in charge of railway equipment and rolling-stock of the British Armies in France. *Consultant Mechanical Engineer*: Sir John Aspinwall, president of the Institution of Civil Engineers. *Traffic Department*: Sir Philip Nash. *Finance and Statistics*: Sir J. George Beharrell. *Development Department*: Rear-Admiral Sir Charles Martin de Bartolome. *Public Safety and Labor*: Sir William Marwood, joint permanent secretary of the Board of Trade. *Roads Department*: Brigadier-General Sir Henry P. Maybury. *Secretarial and Legal*: Sir R. Francis Dunnell.

STEPS are being taken by the Commonwealth Advisory Council of (natural) Science and Industry of Australia to establish a forest products laboratory, at Perth, West Australia, for the purpose of experimenting in the utilization of the by-products of the timber mills and of the forests. With a view to securing all the information available at similar laboratories such as those at Madison, Wisconsin, and Montreal, Quebec, Canada, Mr. I. H. Boas, M.Sc., lecturer in chemistry at the Perth Technical School, has been sent to the United States to conduct inquiries.

THE board of overseers of Harvard University has recommended that the Harvard Botanical Garden should be combined with the Bussey Institution and moved to the grounds of the latter at Jamaica Plains following a report to the board of overseers of the university by the committee visiting the Botanic

Garden. The report is signed by Ernest B. Dane, of Boston, chairman of the committee; Oakes Ames, '98, director of the Botanic Garden; Edwin F. Atkins; George B. Dorr; Arthur F. Estabrook; W. Cameron Forbes; Richard M. Saltonstall; E. V. R. Thayer; Edwin S. Webster. The Botanic Garden is now situated at the corner of Garden and Linnean Streets and contains more than 5,000 species of flowering plants, which are cultivated for educational and scientific purposes. Dr. Asa Gray was its director from 1842 to 1872.

THE *Journal* of the American Medical Association states that the board of directors of the University of Cincinnati on September 9, is said to have rejected the appointments of the faculty of the industrial medicine and public health department made by Dr. Carey P. McCord. This department is not directly associated with the University of Cincinnati, although the board of directors is authorized to make appointments. The financing of the department is by subscription of business men of Cincinnati.

THERE has been established at Paris an optical institute that will work in the interest of the manufacturers of opticians' supplies; it will not be conducted for commercial profit but solely for the purpose of advancing optical science and the optical industries for the common welfare. The forms of activity of this new scientific institute will be: (1) a training school of optics; (2) a laboratory of research and experiment, and (3) a professional school for advanced study. The school of optics will train experts in the manufacture of optical goods. M. C. Fabry, at present professor of general physics at the Faculté des sciences de Marseilles, has been selected as the head of the new institution. M. Lucien Poincaré, rector of the University of Paris, has evinced an especial interest in the institute and has expressed his intention of requesting a professional chair of optics at the Sorbonne. The laboratories will comprise a research department in which the instructors of the school may conduct their theoretical and practical researches with relation to the various kinds of glass, optical instruments

and opticians' accessories, and a department for the study of manufactured products or any matters of importance submitted for examination by the institute. These laboratories will serve likewise for the training of students. The purpose of the professional school will be to train workers in glass, opticians and mechanicians who shall be preeminently qualified.

#### UNIVERSITY AND EDUCATIONAL NEWS

WASHINGTON UNIVERSITY MEDICAL SCHOOL, St. Louis, has received \$300,000 to endow its department of pharmacology. Half of this sum was given by the General Education Board and the other half was raised by the medical school.

MR. P. A. MOLTELNO and his wife have offered the sum of £30,000 to the University of Cambridge, for the erection and maintenance of a suitable building, to be used as an institute for parasitological research in connection with the department of Professor G. H. F. Nuttall.

ASSISTANT PROFESSOR CHAMPION HERBERT MATHEWSON has been elected professor of metallurgy and metallography in the Sheffield Scientific School of Yale University.

DR. HARRY A. CURTIS has resigned his position at the Nitrogen Research Laboratory in order to accept a professorship in chemistry at Northwestern University, Evanston, Ill.

ISRAEL S. KLEINER, Ph.D., formerly associate in physiology and pharmacology at the Rockefeller Institute for Medical Research, has been appointed professor and head of the department of physiological chemistry at the New York Homœopathic Medical College and Flower Hospital, New York City.

DR. J. G. FITZGERALD has been appointed professor of hygiene at the University of Toronto, to succeed Dr. John A. Amyst, who has been appointed deputy minister of health in the Federal Department of Health, Ottawa.

DR. J. PROUDMAN has been appointed professor of applied mathematics in the University of Liverpool.

**DISCUSSION AND CORRESPONDENCE**  
**CHARCOAL ACTIVATION**

At the thirty-sixth general meeting of the American Electro-Chemical Society held in Chicago in September, N. K. Chaney presented a paper on charcoal activation in which he states that the general theory *in its complete form rests* upon two postulates, one of which is "that elementary carbon (other than diamond and graphite) exists in two modifications, 'active' and 'inactive' or *alpha* and *beta*."

It would seem from data obtained here that the definitions of active and inactive would need to be modified before this classification can have any meaning, since charcoal can be made which is the reverse of other charcoals in that it is relatively more active for hydrogen than for nitrogen as shown by the following data:

Each of the volume measurements given were calculated from pressure readings and are reduced to normal pressure and temperature. The amount of charcoal used in each case was 25.7 gms. and this was left at liquid air temperature until saturated. The gases were used separately and not as mixtures.

Charcoal	Initial Volume	Volume of Hydrogen Adsorbed	Volume of Nitrogen Adsorbed
Usual type.....	926 c.c.	914 c.c.	926 c.c. <sup>1</sup>
Usual type.....	1,780 c.c.	1,657 c.c.	1,780 c.c.
New sample 1....	926 c.c.	907 c.c.	666 c.c.
New sample 2....	926 c.c.	900 c.c.	755 c.c.
New sample 3....	926 c.c.	874 c.c.	406 c.c.

The difference in treatment of the last three samples was slight yet Sample 1 shows figures lying on the outside of those for Sample 2, *i. e.*, the figures of Sample 1 have approached each other for Sample 2. Much more striking samples can no doubt be prepared.

A report of this work will be published when completed but this will serve to point out an apparent incompleteness in the theory set forth by A. B. Lamb<sup>2</sup> and by N. K. Chaney.

<sup>1</sup> Not saturated in this particular case.

<sup>2</sup> *J. Ind. and Eng. Chem.*, 1919, 11, 420-467.

The author is indebted to Dr. H. B. Lemon for valuable advice and assistance in this work.

H. H. SHELDON

THE UNIVERSITY OF CHICAGO

**AGED BEAN SEED, A CONTROL FOR  
BACTERIAL BLIGHT OF BEANS**

DURING the progress of the investigational work on bacterial blight of beans (*Bacterium phaseoli* E. F. Sm.) at the Oklahoma Agricultural Experiment Station many measures for control were attempted. The most successful method so far evolved is that of eliminating the disease by the use of aged seed. It was known that the causal bacteria could be cultivated from infected seed for only a limited time.

With this fact in mind the infected seed raised in our experimental plots each year was saved and stored. Seed four and five years old has never produced blighted plants but the percentage of germination has been so low as to prohibit its use under actual farming conditions. Two- and three-year-old seed has with one exception given blight-free plants. This one exception occurred early in the work and in view of later results must be ascribed to accidental infection.

Results secured indicate that the use of two- and three-year-old bean seed furnishes blight-free plants when planted upon uninfected land and at a sufficient distance from other bean patches to insure no accidental infection. Such seed moreover has a sufficiently high percentage of germination to make its use practical under actual farming conditions.

The results of the investigational work which have been completed will be published in the near future.

C. W. RAPP

DEPARTMENT OF HORTICULTURE,  
A. & M. COLLEGE,  
STILLWATER, OKLAHOMA

**NOTE ON THE FLAGELLATION OF THE  
NODULE ORGANISMS OF THE  
LEGUMINOSÆ**

IN again taking up the question of flagellation of the nodule bacteria, the findings re-

ported in a previous paper<sup>1</sup> are confirmed. Proven cultures from *Vigna sinensis* and *Glycine hispida* were repeatedly stained and examined, the organisms in every trial being found to have a single polar flagellum.

Attention was then turned to the organisms, which had before given unsuccessful stains owing to the more abundant slime production. Pure cultures isolated from the nodules of *Trifolium pratense*, *Vicia villosa*, and *Melilotus alba* were tried, this time successfully, though the staining of these organisms is obviously more difficult and uncertain. The bacteria in every case were found to be peritrichous. It was further noted that whereas the organisms of *Vigna* and *Glycine* have a very stout flagellum, the flagella of the organisms from *Vicia*, *Trifolium*, and *Melilotus* are much finer.

This confirms the work of De Rossi, Kellerman, Zipfel, and Prucha (but one convincing photomicrograph exists, that by De Rossi of *Trifolium repens*), and attention is called to the fact that these workers devoted their efforts to the more slimy group, i. e., *Vicia*, *Trifolium*, *Pisum*, *Phaseolus*, *Medicago*.

It is now evident that on the basis of flagellation, the nodule bacteria are to be divided into two distinct groups; the *Glycine-Vigna* group, and the *Trifolium-Vicia-Melilotus* group. Further observations confirming this grouping and dealing with cultural and physiological characteristics as well as with the systematic position of these and related organisms, will be the subject of a paper entitled, "The Nodule Bacteria of Leguminous Plants" soon to be published by Lohnis and Hansen.

ROY HANSEN

ILLINOIS AGRICULTURAL EXPERIMENT STATION

#### THE SUPPOSED SCALES OF THE COTTID FISH JORDANIA

THE Cottidae are in general scaleless, but the rare fish *Jordania zonope* Starks, from Puget Sound, is said to have the body above lateral line closely covered with ctenoid scales. Dr. D. S. Jordan has very kindly sent me fragments of one of the cotypes and

<sup>1</sup> Ill. Agr. Exp. Sta. Bul. 202.

the appearance is exactly as described. But when the material is treated with hot caustic potash, it is found that the apparent scales are nothing more than rows of strong ctenoid spines, placed as they would be in true scales. In the dorsal region the rows are curved as they would be were they margins of ctenoid scales. In the presumably related fossil *Lepidocottus brevis* (Agassiz), from the European Miocene, the ctenoid elements are as in *Jordania*, but the complete scales are present, with the circuli and basal radii as usual. It must be supposed that *Jordania* came from such an ancestor, and represents the survival of certain elements of scale structure without the scales, something like the grin of Lewis Carroll's Cheshire cat.

T. D. A. COCKERELL

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#### REPORT OF THE COMMITTEE OF THE AMERICAN CHEMICAL SOCIETY ON THE PREPARATION OF A LIST RECOMMENDING CHEMICAL TEXTS FOR LIBRARIES

ON January 15, 1919, announcement was made of the appointment of Messrs. W. A. Hamor, A. M. Patterson, and L. C. Newall, as a committee for the preparation of a text for the use of librarians, in recommending books for the chemical reading of the public, in accordance with the suggestion submitted to President Nichols by Mr. Joseph L. Wheeler, librarian of the Youngstown Public Library, Youngstown, Ohio. Following the presentation of its preliminary report<sup>1</sup> at the Buffalo, N. Y., meeting of the society, the committee membership was strengthened by the addition of Mr. Wilhelm Segerblom.

The study of the needs of librarians which was conducted by the committee at the inception of its work, made it clear that what was most desired was an authoritative series of reading courses, and not a mere book-list, on chemical subjects. In fact, Mr. Wheeler formally requested a mode of presentation consisting of running texts so prepared that the

<sup>1</sup> See *J. Am. Chem. Soc.*, 41, 95-96 of *Proceedings*.

"prospect" would become interested in the chemical subjects discussed; and consideration of this view and the results of its own inquiry convinced the committee that, to accomplish the purposes desired, the reading courses should have a very definite publicity plan behind them.

In carrying out its work, the committee has prepared the manuscripts for a series of circulars which, it is thought, will make men want to read chemical literature. In order to accomplish that result, the committee has written lively and appealing essays, of about 1,500 words each, on elementary chemistry, household chemistry, general and physical chemistry, inorganic and analytical chemistry, organic and biological chemistry, industrial inorganic chemistry, industrial organic chemistry, and techno-chemical analysis, all of which have been divided into appropriate paragraphs, worded so as to bring out the importance of the subject and so as to impress the reader with the national essentiality of the chemical profession. Carefully selected books are mentioned casually in the texts of the courses, usually to conclude the paragraphs.

These courses should now be made available for the use of librarians who wish to reach ambitious persons who have the intelligence to follow a course of chemical study. They should, to serve the intended purpose, be published in attractive booklet form for distribution at libraries to persons who are engaged in chemical work or interested in the specific subjects of the various courses, and to persons who are as yet only casually engaged or interested, but who may think of becoming well-informed on chemical subjects.

It is therefore recommended that the committee be authorized to furnish Mr. Joseph L. Wheeler with copies of the manuscripts, in order that he may endeavor to arrange for their publication *in toto*, and that the present committee be designated to cooperate with Mr. Wheeler in that undertaking and in stimulating interest in chemistry through the media of libraries. It is also recommended that the courses be published by the society in *The Journal of Industrial and Engineering Chemistry*.

The committee is grateful for the privilege of rendering this public service, for, as in Carlyle's time, "the true university is a collection of books," expertly selected and properly used.

W. A. HAMOR

MELLON INSTITUTE,  
PITTSBURGH, PA.,  
August 29, 1919.

#### SPECIAL ARTICLES

##### AN UNEXCELLED MEDIUM FOR THE PRESERVATION OF CADAVERS

ONE can not contemplate the history of human dissection without a profound sense of gratitude for the discovery of three chemicals, the use of which in embalming has completely transformed the laboratory of gross anatomy. Could they have been introduced earlier, human dissection long since would have lost its forbidding aspect. Although Scheele discovered glycerin in 1779, it was not used for the preservation of anatomical material until 1868, almost a century later. This was not until a year after formaldehyde had been discovered by Hoffman and, although the antiseptic properties of the latter were not revealed till twenty years later, this event soon was followed by its introduction into histologic and gross anatomic technique in 1890 by Blum, junior and senior respectively. The earlier discovery of phenol by Runge in 1834, with the subsequent relation of its antiseptic properties by the revolutionary usage of it in surgery by Lister in 1867, and its application in the preservation of anatomic material by Laskowski in the same year, or even in 1864, completes the trinity of substances so largely responsible for freeing dissection of the human body from the noisome burden previously imposed by post mortem decay. An occasionally delayed necropsy still can suggest to present-day medical students just what this freedom meant to anatomists and students of anatomy of the past. Surely nothing has been a greater boon to human anatomy and anatomists than the miracle wrought by these and other chemicals, the proper use of which bids fair to make our anatomical laboratories practically odorless.

For unless the bodies can not be obtained soon enough after death to make proper preservation possible, the human anatomist or medical student no longer need labor in an atmosphere which announces their presence even to those who seek them not.

While we have been exceedingly fortunate in the matter of embalming the dead, and have improved upon the historic—or even geographic—method of cold storage by adapting current commercial equipments, much yet remains to be desired in this respect. Several years since, while reflecting upon the various methods now in use, it occurred to me that mineral oil ought to possess many advantages. Since various vegetable oils, notably turpentine, oil of cedar, benzol, etc., had been used, it seemed strange indeed that mineral oils also should not previously have been resorted to. This would seem particularly likely during the last decades in which oil played such a very prominent rôle in the industries. It seemed all the more perplexing that mineral oils should not have been resorted to because resins, pitch, tar, etc., had been used centuries ago for the very purpose. Moreover, attempts also had then been made to imbed the dead in honey, resin and fats, after the manner of nature in imbedding insects in amber. It is true that nature also made such experiments with crude oil on a gigantic scale at La Brea, but that is a relatively recent discovery. Nevertheless, it seems strange that the finding of these beds with their rich booty, some years since did not suggest the use of mineral oils for the storage of anatomic material to me or, for that matter, to others. Indeed it is so inexpensive when contrasted with cold storage that it seems that it could not have been overlooked in the course of the development of modern methods for embalming and preserving material for dissection. However it is possible that the use of crude oil was considered and abandoned before the development of modern methods of distillation, because crude petroleum very plainly would seem to be quite unsuited for the purpose.

Cold storage, while excellent for the preservation of material for short periods of time,

demands not only a considerable initial expense, but also imposes a relatively high cost of maintenance. With its use it also is difficult to prevent marked shrinkage of the material, in the course of months and years. The same thing applies to the storage of material in tanks over methyl alcohol. Immersion in a watery solution, on the other hand, while obviating this difficulty, introduces others. Since the water penetrates the bodies, it abstracts the preservatives from the tissues, and bodies so immersed dry quickly when exposed to an atmosphere of low humidity. While drying during storage is obviated by submersion in watery solutions the bodies often remain at or come to the surface and must then be depressed. Evaporation of the water also carries odors with it, besides reducing the total quantity of fluid. A room full of tanks containing oil on the other hand remains practically odorless and needs no further attention.

While most of the difficulties except drying experienced with other methods are obviated by storage of the cadavers on open racks after covering the material with a thick coating of vaseline, the application of the latter is time-consuming, relatively expensive, and does not make for tidiness. Moreover, portions of the skin easily become uncovered of vaseline and dry, and when the nose, mouth and eyes are not thickly coated, mold also can get a foothold, in spite of the extra wrapping required.

With the use of all these methods, except immersion in a water solution, inspection of the material is difficult, while it is exceptionally easy with the use of oil. Moreover, the oil extracts practically nothing from the material and softens and later protects the epidermis. Since its specific gravity is low, bodies easily sink by their own weight. Hence, as long as there is sufficient oil in the tanks, all material is hermetically sealed and no spontaneous subsequent exposure need be feared, for there is practically no loss through evaporation. Material stored in it for over two years appears to be in identically the same condition as when first immersed. Since bodies which have become decidedly œdematos during the process of embalming may be ex-

posed over methyl alcohol for varying periods of time before immersion in oil, one can always reduce, even if not totally remove, the inevitable distortion due to the injection of considerable quantities of preservative, and be assured that the material comes out of the oil unchanged. Since carbolic acid when warmed, easily and thoroughly mixes with oil, it can be added if desired, but so far I have not observed the least disadvantage from the use of unmixed oil alone.

Material immersed in oil need drain only a few minutes before it can be wrapped or covered and used for dissection. The wrapping quickly takes up the slight amount of adhering oil, and by being impregnated with it, greatly slows the drying out of the material. Except for the slight odor of the oil, bodies so stored are practically odorless, and quite in contrast to those kept in watery solutions, leave practically no evidence of external contact even when handled with bare hands. After being thoroughly impregnated with oil the epidermis resists drying very much better, and the eyelids, nose, lips, digits, ears and genitalia do not require such careful protection during dissection. But above all else the untidiness and soiling, unavoidable especially when vaseline is used, are wholly obviated.

Since any wooden tank can be used as a container, no expensive equipment is required. A galvanized iron lining no doubt will last indefinitely, and cement tanks have not been found too pervious. Exposure to cold can cause no difficulty, and, if introduced accidentally, water can be drawn off easily. The cost of the oil is low, especially when its practical permanence is considered, and since it is not easily ignited until it reaches a temperature of 80° C., underwriters have raised no objections to its use. Lighted matches can be thrown into open tanks without causing an explosion of gases or igniting the oil. Indeed some heating of the latter when contained in an open vessel is necessary before explosion of the liberated gases occurs. Consequently, ordinary care is all that is required to avoid accident when in its presence.

The particular grade of oil which I have used for several years is known as mineral seal oil. It has a slight yellowish tinge, and a specific gravity of 0.85 at room temperature. It has only a slight odor, which is wholly inoffensive, and, in fact, negligible. Since it can be obtained in large quantities and does not need renewal, it is extremely economical, and since it is almost colorless, it can be used to advantage also for preserving smaller specimens and even for museum preparations. It indeed seems to be an unexcelled medium for the storage of anatomical material. That this estimate of it is justified seems to be indicated also by the experience of friends who are using it. It would seem to be particularly advantageous when it is necessary to store material for long periods of time because of an intermittent or insufficient supply, or when, for some reason, it is desired to repeat measurements or to make volumetric determinations, at a later date.

ARTHUR WILLIAM MYER  
STANFORD UNIVERSITY

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THE AMERICAN CHEMICAL SOCIETY.  
VI

RUBBER DIVISION

John B. Tuttle, *Chairman*  
Arnold H. Smith, *Secretary*

Report of Executive Committee.

Report of Secretary.

Report of Fruit Jar Ring Committee. L. J. PLUMB, *chairman*.

Report of Committee on Physical Testing. H. E. SIMMONS, *chairman*.

*A new method for the determination of sulfur in rubber mixtures:* G. D. KRATZ, A. H. FLOWER AND COLE COOLIDGE. Transfer the finely divided samples (0.5 gm.) to an Erlenmeyer, and add 10 c.c. of ZnO + HNO<sub>3</sub> solution (200 gms. ZnO in 1 liter HNO<sub>3</sub>). Then add 15 c.c. fuming HNO<sub>3</sub>, whirling the flask until the sample is decomposed. When solution of the rubber is complete, add 5 c.c. Br-H<sub>2</sub>O and evaporate mixture to a foamy syrup. Cool flask and add a few crystals of KClO<sub>3</sub>. Evaporate the mixture to dryness and bake at the highest temperature of a Tirrell burner until all nitrogen compounds are eliminated. When baking is

complete, cool, take up in HCl (1:6), filter and precipitate sulfates in the usual way, especial care being observed in washing BaSO<sub>4</sub> free from chlorides. The method is accurate to 0.1 per cent.

*The extraction of rubber goods:* S. W. EPSTEIN AND B. L. GONYO. A report is made of experimental work on the rubber extraction of rubber goods, with tables showing results obtained. The observations and conclusions derived from this work were as follows: (1) Extraction for 8 hours with acetone followed by 4 hours extraction with chloroform does not remove all soluble material from some rubber compounds. (2) After a rubber sample has been extracted with acetone it was found: (a) that chloroform in every case extracted slightly more material than carbon bisulphide; (b) that constant boiling mixtures such as 55 per cent. carbon bisulphide—45 per cent. acetone and 68 per cent. chloroform—32 per cent. acetone extracted from many cheap compounds considerably more material than either chloroform or carbon bisulphide; (c) that usually about 0.1 per cent. of sulphur is present in the extract, whether it is obtained by the use of chloroform, carbon bisulphide, or the mixtures under consideration. (3) The constant boiling mixture of 68 per cent. chloroform and 32 per cent. acetone exhibits a marked ability to dissolve vulcanized rubber, as contrasted to the mixture of 35 per cent. carbon bisulphide 45 per cent. acetone which hardly exhibits this ability at all. (4) It is recommended that the constant boiling mixture 55 per cent. carbon bisulphide and 45 per cent. acetone be used in place of acetone and chloroform to extract rubber samples since: (A) It eliminates one extraction with the necessary weightings. (B) Extraction is complete in 8 hours while the acetone and chloroform extractions require a total of 12 hours. (C) The extraction of free sulphur is complete. (D) A rubber analysis in which the mixed solvent is used, is more accurate than that in which acetone and chloroform are used, because (I.) Little or no rubber is dissolved by this mixture, as compared to chloroform which will in some cases dissolve considerable quantities. (II.) The extraction of cheap rubber compounds is more complete, since the extracts obtained are greater than the sum of the acetone and chloroform extracts.

*The theory of balloon fabric protection:* JOHN B. TUTTLE.

*The expansion of rubber compounds:* C. W. SANDERSON. A new apparatus was designed to

measure the expansion of rubber compounds during vulcanization. Values of the coefficient were determined for different classes of compounds and found to be between  $2.3 \times 10^{-4}$  and  $3.8 \times 10^{-4}$ . A study of the relation between the expansion and the increase in specific gravity was made and the conclusion drawn that the increase in specific gravity during vulcanization is due to the pressure exerted on the rubber. Other experiments were made to determine the applicability of the measurements to commercial practise.

*Volume increase of compounded rubber under strain:* H. F. SCHIPPEL. The addition of pigment to rubber changes it from a substance which has constant volume under strain, to one which undergoes comparatively large volume increases. The amount of this increase depends upon three factors: (1) the extent of strain, (2) the volume proportion of pigment, (3) the average particle size. The larger sized pigments cause greater volume increases, with the notable exception of zinc oxide, which classifies itself under this test with the finer pigments. Prolonged mixing on the mill has only a slight reducing effect upon the volume increase. This general property of rubber compounds throws light upon their physical condition under strain.

*The determination of cellulose in rubber goods:* S. W. EPSTEIN AND R. L. MOORE. After a discussion of the value of a procedure for determining cellulose in rubber goods and consideration of the literature on the subject, the proposed method is discussed. Sample is digested with cresol at 160°–185° C. for 4 hours to dissolve the rubber. Filtration is facilitated by addition of a 200 c.c. of petroleum ether. After washing with benzol, 10 per cent. solution of hydrochloric acid, water and acetone, the material is dried and weighed. It is then acetylated by heating for 30 minutes at 75° C. in a mixture of 15 c.c. of acetic-anhydride and 0.5 c.c. of concentrated sulphuric acid. This is filtered on a weighted Gooch, washed with 90 per cent. acetic acid and then with acetone and dried and weighed. Loss in weight is recorded as cellulose. Under Results of Analysis are given a number of test compounds, containing varying amounts of cellulose in the presence of various combinations of compounding ingredients. The results by method given indicate its gratifying accuracy. A number of alkali reclams are given along with cellulose content as obtained by method proposed. It is shown how the percentage of cotton can be

obtained in the presence of leather. Leather, wood, jute and cork are considered. These are broken down by cresol at 185° C. For this reason it is suggested that rubber be digested in cresol for 16 hours at 120° C. when the presence of these is suspected. At this temperature the basic substance of these materials is retained intact. Acetylation gives:

95 per cent. of the wood,  
90 per cent. of the jute,  
70 per cent. of the leather,  
21 per cent. of the cork.

An approximation of the amount of cork present is obtained by treating the residue after acetylation with 2 per cent. solution of sodium hydroxide and strong bromine water, in order to remove the unacetylated cork. The loss in weight represents 70 per cent. of the total amount of cork present. It was found impossible to determine each of these ingredients separately, and therefore it was decided to determine them collectively by the acetylation method, and to test for the presence of each by means of proper stains and microscopic examination.

*The variability of crude rubber:* JOHN B. TUTTLE.

*Symposium on the action of accelerators during vulcanization:* J. H. SCOTT.

*The action of certain organic accelerators in the vulcanization of rubber:* G. D. KRATZ, A. H. FLOWER AND COLE COOLIDGE. The activity of the following substances in accelerating the vulcanization of a mixture of 92½ parts rubber and 7½ parts sulfur was investigated: aniline, urea, thio-urea, mono- and di-phenyl-thio-urea, mono-, di- and tri-phenyl-guanidine, the formaldehyde condensation products of aniline and p-phenylene-diamine, and other substances, including those which produce negative acceleration. Comparisons were made on the above mixture; sulfur coefficients are given. Certain substances were found to decompose into simpler substances containing an active nitrogen group which is responsible for the acceleration effected. Molecularly equivalent quantities of substances which contain the same active nitrogen group in their primary nucleus produced the same accelerating activity. Certain nitrogen groups probably function as sulfur carriers with a temporary change from three to five in the valency of the nitrogen.

*Reactions of accelerators during vulcanization:* C. W. BEDFORD AND WINFIELD SCOTT.

*The effect of organic accelerators on the vulcanization coefficient:* A brief discussion of the already published work on the relationship of the mechanical properties of vulcanized rubber to the chemical composition, and a description of experiments with certain powerful accelerators which demonstrates that under certain conditions good mechanical properties can be obtained in rubber with a very low degree of chemical combination of sulphur.

*The effect of compounding ingredients on the physical properties of rubber:* C. OLIN NORTH.

*Some methods of testing the hardness of vulcanized rubber:* H. P. GURNEY.

*Symposium on the testing of pigments.* Led by GEO. OENSLAGER. Contributions from M. M. Harrison and M. M. Kahn.

*The manufacture and use of crimson antimony:* J. M. BIERER.

*Laboratory aprons:* C. P. FOX.

*The value of a library to the rubber laboratory:* H. E. SIMMONS.

*Research on zinc products for the rubber industry:* P. R. CROLL AND I. R. RUBY.

#### DYE SECTION

Charles L. Reese, *Chairman*

R. Norris Shreve, *Secretary*

*Introductory remarks:* CHARLES L. REESE.

*Present condition of German dyestuff plants:* T. W. SILL.

*Review of the dye situation:* J. MERRITT MATTHEWS.

*The progress of the American dye industry as shown by the census of the Tariff Commission:* GRINNELL JONES.

*Photosensitizing Dyes:* E. Q. ADAMS.

*The color laboratory of the Bureau of Chemistry:* H. D. GIBBS.

*Alkali fusions:* H. D. GIBBS AND MAX PHILLIPS.

*The system: naphthalene-phthalic anhydride:* K. P. MONROE.

*The melting point of pure phthalic-anhydride.*  
*The system: phthalic anhydride-phthalic acid:* K. P. MONROE.

*Benzene sulphonic acids. (I.), benzene disulphonic acid from benzene mono sulphonic acid:* C. E. SENSEMAN.

*Notes on testing dyed goods:* W. F. EDWARDS.  
During the war period established prejudice made

a condition that favored placing the blame for defects in dyed goods on the dyer and the American Dye Manufacturers. It has been an easy way for uninformed persons dealing in dyed finished goods to avoid responsibility for defects in the goods which they handle. It is necessary to show these dealers in dyed goods that there are ways of practical testing within their reach that are comparatively safe in showing the color quality of the goods they handle. This would be also great value to the dyer and dye manufacturer as the tests could be made by disinterested laboratories. These tests should be simple and reliable and as fast as possible standardized. The textile testing department of the United States Conditioning & Testing Co. has been making some investigations along this line and have done enough to show that it is quite practical to place the color quality of dyed finished goods on as sound a basis of specification as now obtains for steel and other alloys. In the case of steel the specifications are in terms of chemical analysis, micro-structure and physical tests. In the case of dyed finished textiles the specifications for color quality are in terms of fastness in some form or other and hue, saturation and brilliancy and are determined by empirical tests under controlled conditions. These are details of standardization of these empirical tests that are important to consider from the point of view of the manufacturer of dyes, the dyer and the dealer in dyes and dyed finished goods. Team work by all will lead to results that will insure the future of the American dye industry.

*The quality of American dyestuffs:* R. S. LUNT. After a review of pre-war dyestuff conditions the author spoke of the early attempts to produce intermediates and dyestuffs in America. The first dyestuffs produced for large tonnage though few in variety. Indigo, only commenced in 1917, now supplies the entire demand. The study and production of alizarines and vat dyes required time but these colors are now almost ready to put on the market. Azo colors, forming the bulk of the production, form a varied line. The Chemical Foundation has provided access to German owned American patents. Present dyestuff industry now comprises 215 concerns employing 26,000 hands, of whom 2,300 are chemists. The great need of the dyestuff chemist is pure standardized intermediates, 141 are now being made. Most manufacturing problems are due to lack of experience. Standardization must rest on a basis of commercial

products rather than on chemical purity. The present productions are satisfactory but there is a need of press cooperation and favorable legislation. The American chemists are now in control of the situation.

*Application of dyes:* E. W. PIERCE. The author first shows the earliest methods of coloring fabrics by printing and dyeing, tracing the progress of the art to the present high state of development. It is shown that dyes must be more than mere colors; they must have definite characteristics and be practical in their applications. Many possible dyestuffs are little used for lack of proper methods of application. The uses and possibilities of any dye determine its value more than any other factor. The importance of technical service is shown in its relations to both the dye maker and the consumer, also the future development of the industry, dependent on the verdict of the technical department, which will determine which new dyes shall be introduced and which ones are not capable of practical development.

*Foreign dye patents:* ROBERT E. ROSE. The difficulty of ascertaining the method of making dyes, even those covered by patents, is much greater than is appreciated, a fact which has never been given publicity. The paper explains the reason for this and shows that overcoming this difficulty is one of the most important tasks before the dye chemists of the country.

*Some stones in the foundation of a great national industry:* THOMAS H. NORTON. The effort to build up an American coal-tar dyestuff industry, fully equipped to meet the rivalry of the German industry, is outlined. The chief factor in favor of the latter is its enormous capital of accumulated experience and perfect organization. Details are given of the principles and methods employed by the du Pont Company in seeking to establish color works on American soil, equal in extent and variety of product, to any of the giant works on the Rhine. Emphasis is laid upon the work of the "Intelligence Division" which furnishes prompt, accurate and full information on any subject arising, to the numerous divisions engaged in operation or research.

*The explosibility and inflammability of dyes:* BURR HUMISTON, W. S. CALCOTT AND E. C. LATHROP. A presentation of the factors which cause decomposition of dyes during drying grinding and mixing with special emphasis on explosion and fire risk. Decomposition is due to temperature effects, especially dangerous in exo-

thermic decompositions. The laboratory methods used are designed to deal with decompositions in both solid and dust air phases. Preliminary results are promising finding application in plant practise, insuring more uniform quality in the dyes produced.

*Some problems in the identification of dyes:* E. F. HITCH AND I. E. KNAPP. It is pointed out that before the American dyestuff manufacturers can develop new colors, they must be able to duplicate the staple foreign dyes, especially the more recent ones, and those which are unclassified. In order to do this it will be necessary to identify these dyes, and in many instances to determine their chemical constitution. The first class of problems that are likely to be met includes (1) the identification of two or more dyestuffs, the composition of one of which is known; (2) the determination of the chemical constitution of an unknown dyestuff; and (3) the separation and identification of the component of a mixture of dyestuffs. The problems in class two deal with the identification of dyestuffs on the fiber. The methods which have been proposed for the solution of these problems are reviewed. In conclusion, a plea is made for closer cooperation between the universities and the dyestuff industry. Several ways are shown in which such cooperation might be effected.

*Indicators and their industrial application:* H. A. LUBS. The most recent and useful developments in the field of indicators are largely due to need for a series of brilliant and sensitive compounds for the colorimetric determination of  $H^+$  ion concentration of biological fluids. This necessity has given rise to the study of the ranges, and of the salt, protein and other errors of a large number of compounds, as well as to the synthesis of new indicators. The sulfophthalein series of indicators are brilliant compounds and cover a wide range of  $H^+$  ion concentration. These compounds are superior in a number of respects to indicators in general use at the present time and their application in a number of industrial operations would be highly advantageous. The lack of reliability in the case of test papers of litmus and phenolphthalein is pointed out and the use of sulfophthaleins is suggested. Examples of certain procedures in the preparation of dyes and intermediates in which indicators can be of assistance are given.

*Vat dyes:* M. L. CROSSLEY.

*Gentian violet and its selective bactericidal action:* M. L. CROSSLEY.

*The importance of intensive and original research in the development of the dye industry in America:* M. L. CROSSLEY.

*Logwood in its relation to the silk industry:* EMIL LESSER AND DAVID WALLACE.

*Some engineering aspects in the manufacture of dyes:* CLARENCE K. SIMON.

*Observations on the estimation of the strength of dyes:* W. H. WATKINS.

*Application of physical chemistry research on dyes:* E. K. STRACHAN.

*Crystallographic identification of five isocyanines:* EDGAR T. WHERRY. Five isomeric or closely related isocyanine dyes have been prepared in the Color Investigation Laboratory of the Bureau of Chemistry by Dr. E. Q. Adams, and crystallized from alcohol. The crystals prove to show brilliant color phenomena, and especially the rare effect known as reflection-pleochroism, the reflection of light of different colors in different crystallographic directions. Models of these crystals have been prepared (and were exhibited at the meeting). It is ordinarily not practicable for any one not specifically trained in crystallography to carry out measurements of interfacial angles of random crystals, because it is a matter of great difficulty to orient given crystals correctly. The fact that the crystals of these dyes have definite colors associated with definite crystallographic directions makes such orientation comparatively easy, and which dye is represented in a given sample can be rapidly and certainly ascertained by a few simple observations of angles, far more readily than by any known chemical method.

*The dye situation in the United States and England:* T. FRUSHER. CHARLES L. PARSONS,  
Secretary

(To be continued)

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